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INCREASING THE PRODUCTION OF OYSTERS AND OTHER SHELLFISH IN THE UNITED STATES

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DECLINE OF THE OYSTER FISHERY

A hundred years of practical experience has demonstrated that the yield of the shellfishery can be materially increased by farming or cultivation. Nevertheless, production of oysters in this country during the past years has been declining. Taking as an illustration the figures for the last few years for which complete statistical data are available, we find that the total yield declined from 95.6 million pounds of oyster-meat in 1937 to 93.1 in 1939 and 89.4 in 1940. Even the substantial growth of Pacific Coast oyster production from 7.8 to 10.8 million pounds during these years was not enough to counterbalance the general trend. Statistics for 1940 show that more than fifty percent of oyster meats, namely, 48.7 million pounds, were produced on privately-owned or -leased bottoms as compared with 40.68 million pounds obtained from public reefs.

The present yield is much smaller than that gathered years ago. Thus, in 1890-92 the total production of oysters was probably not less than 182.8 million pounds of meat* (table) and Maryland alone contributed at least 70.8 million pounds, or about 79 percent of the total amount produced in 1940. A steady decline in oyster production to approximately half of that of 50 years ago is due primarily to the system of free fishing under which the full utilization of our oyster grounds is impossible. Pollution of inshore waters by industrial wastes and domestic sewage is another factor in the decrease, resulting in the closing of productive grounds by Public Health authorities, or, in certain instances, the destruction of the shellfish themselves by accumulation of toxic or decomposing matters.

The total acreage of oyster bottoms in our coastal waters can be estimated only approximately. According to present computations, there are in the territorial waters of the United States about 1,428,500 acres officially designated as oyster-producing bottoms. A small proportion of this area, not exceeding 185,000 acres of privately-leased or -owned bottoms, produces 54.5 percent of the total oyster crop. There is, thus, a very great difference in the productivity of cultivated and natural oyster beds. One must remember, however, that there are considerable areas of privately-leased grounds which, for various reasons, are not cultivated and that many of the natural oyster reefs or rocks at present include areas that are totally devoid of oysters and, therefore, do not contribute to the fishery. In many States, their utilization for oyster farming is impossible, however, because of legislation which prohibits the leasing of natural beds.

The state of depletion of the public oyster grounds can be illustrated by several examples. The best one is found in Georgia. According to Drake, Coast and Geodetic Survey Bulletin No. 19 (1890), there were within the waters of that State 30,000 acres suitable for oyster cultivation. In 1908 these produced 1,446,100 bushels of these shellfish. In 1923, the production had dropped to 245,762 bushels and, in 1937, was only 28,872 bushels increasing, however, in 1939, to 78,133 bushels. In 1937, Georgia oysters were the poorest in the country, yielding only 2.75 pounds of meat per bushel. Thus, the oyster fishery in Georgia almost ceased to exist and the canneries which still operate in the State are dependent on supplies from South Carolina. No outside causes, as floods, dredging of navigable waters, filling-in of bays and estuaries with dredged material, can be blamed for the destruction of the industry which once brought more than $300,000 annually to the Georgia oystermen. The principal cause of this decline was the system of management, or rather, mismanagement of the natural resource, under which destructive methods of harvesting were not only tolerated but encouraged. The responsibility rests equally with the canners who were buying cluster-oysters and who never bothered to return small, undersized individuals to the grounds, and with the State government which made no effort to protect the natural supply of oysters by establishing spawning reserves, enforcing cull laws, planting cultch, or employing similar conservation measures.

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*Computations were made by using the factors of yields for 1939 given in "Fisheries Industries of the United States, 1941", Administrative Report No. 41, published by the Bureau of Fisheries, now a part of the U. S. Fish and Wildlife Service.

Production of Oysters in the United States in 1890-1892 and in 1939 in pounds of oyster meat

States	Pounds of meat per State-bushel 1939	Total pounds of meat	
		1890-92	1939
Massachusetts	6.57	381,106	269,800
Rhode Island	7.00	1,210,615	2,313,500
Connecticut	7.63	14,803,528	5,222,200
New York	7.50	19,582,965	6,272,700
New Jersey	6.05	15,924,308	5,096,100
Delaware	7.00	1,227,324	285,100
Maryland	6.09	70,843,326	20,342,300
Virginia	5.92	35,429,045	16,504,300
South Carolina	5.98	377,637	1,719,400
North Carolina	5.56	4,488,365	1,055,600
Georgia	6.83	1,532,345	234,400
Florida	4.74	2,220,363	1,065,500
Alabama	5.01	2,410,161	1,357,700
Mississippi	5.30	4,274,333	7,706,400
Louisiana	4.63	3,896,538	13,586,400
Texas	4.38	1,930,704	987,300
Total		180,532,663	84,018,700
Washington	7.00	999,110	8,526,900
Oregon	7.00	17,500	215,300
California	7.00	1,250,515	245,600
Grand Total		182,799,788	93,006,500

Depletion of oyster bars in the upper part of Chesapeake Bay is another example of the gradual exhaustion of natural resources under a system of "free" fishing. According to the estimate made by Edwin G. Baetjer of the Maryland Board of Natural Resources, the average production of oysters on the 130,000 acres of the so-called dredger's area in Chesapeake Bay has been reduced from 54 bushels to 4 bushels per acre, or less. The inadequacy of restrictive measures enforced in this State, but not accompanied by a program of cultivation, is further demonstrated by conditions in the Potomac River. According to the survey made in 1928 by the former U. S. Bureau of Fisheries, now part of the Fish and Wildlife Service, the population of oysters in the river averaged 0.9 bushels per acre. A 14-year period of restricted fishing during which dredging on these bars was prohibited by the State of Maryland, but permitted by Virginia, resulted in only partial recovery of the resource. The present oyster population, as estimated last winter by the Fish and Wildlife Service, averages 8.9 bushels of marketable oysters per acre. This is only a very small fraction of the population that could be maintained under cultivation on an oyster bottom capable of supporting from 500 to 1,500 bushels of oysters per acre.

LEGISLATIVE MEASURES

The fact that continuous fishing on natural oyster beds leads to their rapid exhaustion was recognized long ago. The earliest, and probably the first, regulation concerning the oyster fishery in this country was passed on June 4, 1661, when the Court held at Plymouth, Massachusetts, enacted "that five shillings shalbee payed to the Countrey vpon every barrell of Oysters that is carryed out of the Gov'ment . . ." (Quoted from Ingersol, The Oyster Industry, 1881, p. 20), and nineteen years later on the 7th of July 1680, the 2nd Session of the General Court at Plymouth ordered "that such as are not of our collonie be heerby prohibited of fetching oysters from Taunton River with Boates or any other vessells . . ." Seizure of such "boates and vessels for the collonie's vse" was a punishment for the transgressors of this regulation.

While the New Englanders already realized the value of their shellfisheries and took steps to protect them, the people of Maryland thought so little of the value of oysters as food that in depositions made by the "Kent Islanders" in the famous Claiborne suit of about 1680 they cited among their grievances and hardships "that their supply of provisions becoming exhausted it was necessary for them, in order to keep from starvation, to eat the oysters taken from along the shores" (quoted from C. H. Stevenson, 1894, The Oyster Industry of Maryland, p. 208).

Conditions were different in 1820. By that time the oyster industry of the State reached such a development that the General Assembly of Maryland passed an act which prohibited, under penalty of a fine of $20 or sixty days' imprisonment, the use of any implements in catching oysters within the State other than the ordinary tongs, and also, the transportation of oysters out of the State in vessels that had not been owned wholly by a citizen of the State for the preceding twelve months. The reasons for this enactment are clearly stated in the following quotation from its preamble: "Whereas . . . a great number of large vessels from the Northern

and Middle States frequent our waters for the purpose of transporting oysters to those States; and whereas well-grounded apprehensions are entertained of the utter extinction of oysters in the State, as well in consequence of the immense quantity thereof exported as the destructive implements used in catching them: Therefore, . . ."

As the one hundred and twenty-two years of history of the Maryland oyster industry show, apprehensions of "utter extinction of oysters," was well-founded. Moreover, numerous attempts to conserve the fishery by purely restrictive measures, produced no good results. Oyster bars, subject to intensive dredging, became depleted, and the natural propagation of oysters could not keep pace with the rate of fishing. A general decline in production followed, and the yield of the largest oyster-producing area in the world diminished to only a fraction of what it was fifty years ago.

The decline of the oyster industry in Maryland attracts special attention, because in no other state of the Union has the legislative body devoted so much of its time to the consideration of oyster laws and regulations. It is said that since 1820, the greater part of the time of the Maryland General Assembly has been devoted to the discussion and enactment of oyster laws, and that the number of general and County measures adopted by this legislative body surpasses the total dealing with all other subjects. Certainly, there has been no lack of legislative attention to the oyster problems of the State. The record indicates the vital importance of the oyster industry to the people of Maryland, but at the same time shows the futility of attempts to solve the problem of oyster conservation solely through laws and regulations.

No serious efforts have been made to rehabilitate the depleted bottoms by introducing a system of cultivation of oysters. The same is true of other states; the policy of free fishing on public reefs has been maintained, and oyster farming by private enterprise was discouraged, and sometimes made virtually impossible through lack of adequate legal and administrative protection. Oyster-farming cannot be expected to progress if the bottom leased to a private planter can be taken away from him on the testimony of two or three citizens, testifying under oath that the ground in question was formerly a natural oyster bed and produced oysters in quantities sufficient to provide profitable fishing. Disregard of property rights, poaching and stealing of oysters from private grounds, and leniency of courts in dealing with trespasses present in many States almost insurmountable difficulties to the establishment of oyster cultivation.

NATURAL OYSTER BEDS AND CONSERVATION

Legal definitions of a natural oyster bed vary from state to state, are usually ambiguous and are, therefore, subject to different interpretations. Although some of the states recognize that natural beds may cease to produce oysters in commercial quantities and, therefore, should be leased to private oyster growers, the period of time required for the ground to remain nonproductive before it can be leased is too long. When such a bed becomes available to private growers, it may be so nearly destroyed that it is no longer desirable.

The oyster laws of virtually every coastal state contain provisions of conservation intent, such as restrictions on gear or rate of fishing, closed periods, and requirements for culling, and return of a certain portion of the shells to the natural beds. While sound and justified by the circumstances, these measures are shown to have been ineffective by the present condition of the natural grounds.

Failure of the laws is probably a result of our faulty concept that the adoption of a new regulation is by itself sufficient to solve a problem of conservation. The facts, however, show that the enactment of numerous conservation laws had little effect in conserving the oyster beds, and that honest enforcement of the restrictive measures failed to stop depletion.

The reason for this unfortunate result is that, at the present time, under the most favorable conditions, the rate of natural propagation and growth of the oyster population is too low to replace the stock taken by commercial fishermen. However, the productivity of oyster beds can be materially and rapidly increased by adopting a system of cultivation and by applying proper methods of oyster farming.

PLANTING OF SHELLS AND SEED

In the absence of a definite system of management, incidental measures such as planting of shells and seed or enforcement of cull laws, etc., are incapable of protecting our resources from further deterioration for they deal with only a few phases of oyster cultivation while neglecting others that are equally important. Obviously, there is no reason for planting shells in a location where setting cannot be expected because of the lack of spawners, fouling of shells, or for some other cause. Yet millions of dollars and thousands of tons of shell have been wasted in the past to comply with the law demanding that shells be returned to oyster bottoms. Huge rehabilitation projects carried out only a few years ago by some of the states, as part of the national relief program, involved the transplanting of millions of bushels of shells and seed oysters. So far as the restoration of the oyster beds was concerned, the results were entirely out of proportion to the money spent, and in many instances were negative. In several well-known cases, failure was due to the ignorance or inefficiency of the supervisors of the projects who piled oyster shells on the bottom of the sea in heaps several feet high with the expectation that tides and currents would distribute them; planted them in polluted areas where fishing is prohibited; or mistook a small noncommercial variety of oyster (O. equestris) for a year-old eastern oyster and transplanted thousands of bushels of this "seed" which of course never increased in size and only damaged the beds. Even when large scale planting operations on public beds were carried out intelligently and skillfully, they resulted only in a temporary improvement, for the supply of marketable oysters was removed within a few weeks after the grounds were opened to fishing.

Planting of seed or shells by the government is considered by many as an indirect subsidy to the dredgers and tongers. Even as a subsidy, the system is not effective because the benefit obtained from it is of

very short duration. It does not result in permanent improvement of grounds and under present conditions has very little value as a conservation measure. Yet it is a well-established fact that planting of shells and seed is the principal operation employed by every oyster grower in the cultivation of oysters. The state governments fail to obtain even a small degree of success in rehabilitating public grounds because, not having a comprehensive or continuous system of management, they are not in a position to determine what should be undertaken under existing circumstances. In deciding when, where, and how many shells or seed to plant, or when and under what conditions the marketable oysters should be harvested, they often act in ignorance or are influenced by political considerations.

PRODUCTIVITY OF OYSTER BOTTOMS

Maintenance of oyster bottoms on a sustained yield basis and full utilization of the potential productivity of oyster grounds are possible but can be achieved only as a result of a well-planned and carefully executed system of cultivation. Thus, if public oyster grounds are to return to productivity, their management must take into consideration the suitability of bottoms for catching seed or for growing marketable stock; the rate of growth of oysters; the natural productivity of bottoms; establishment of spawning grounds; and planting of cultch. Plans must be worked out after the adaptability of the existing bottoms for definite phases of oyster farming has been ascertained, and the extent of various areas and their potential productivity determined.

An estimate of the present assets of the oyster fishery indicates that the potential yield of our public oyster grounds is far greater than their present crop. There are at present about one and a quarter million acres of oyster grounds which yield only about 45.2 million pounds of oyster meat--or on the average from 5 to 6 bushels of oysters in the shell per acre. Many of these grounds are so depleted that they no longer attract the oystermen who, naturally, seek more prolific areas. The average figure of productivity is, therefore, too low because it includes areas, which, at present, do not contribute to the fishery. If through the application of methods of cultivation 500,000 or less than half of the total number of acres could be made to produce annually about 30 bushels per acre, a total yield from public grounds of between 75 and 90 million pounds of meat, or about twice the present amount might be expected.

Of course, such an improvement cannot be made in a short time. Usually much more time is required for the restoration of a natural resource than for its destruction. The sooner, however, we adopt a policy of better management, the sooner we can expect results. From the example of the cultivation of the Pacific oyster in the State of Washington, we know that within a few years the yield of this industry grew from virtually nothing to about 10.7 million pounds annually with the expectation that production can be increased materially in 1943 and 1944. This is an outstanding example of the success of oyster farming conducted by private enterprise and with very little encouragement by the government. Despite this achievement, there exists in many states almost unconquerable opposition to the idea of private oyster culture so that attempts to obtain legislation liberalizing the conditions for the leasing of natural beds are doomed to failure. This situation leaves the state governments no other alternative but themselves to engage in the cultivation of oysters.

CULTIVATION OF OYSTERS

There are various degrees of cultivation. The most elaborate system practiced by the large commercial concerns in northern waters comprises several distinct operations such as, preparation of bottoms, planting cultch to catch spat, transplanting it to growing grounds, planting of young oysters grown from spat to maturing and fattening ground, and harvesting and preparation of the oysters for the market. An almost complete lack of cultivation is found, for instance in Georgia, where the supply of oysters for canneries and shucking houses is obtained from badly neglected and depleted public grounds or is imported. Oyster culture in Delaware and New Jersey is in an intermediate condition for the growers are partly dependent on the existence of public reefs from which to obtain seed for planting on privately-owned beds.

Since the limits of this leaflet do not permit a detailed discussion of the legal and technical problems of individual States, certain basic principles are outlined which, with necessary modification, can be applied to a variety of local conditions. One must bear in mind that natural oyster beds cannot produce as many oysters as can cultivated bottoms. The chief reason for this is that the wild population of the natural bed is composed of various age groups which, to a certain extent, interfere with each other. Spat and seed attach themselves to the adult oysters and compete with them for water, oxygen, and food. Some of the small oysters cannot be culled off, and are destroyed when the catch is delivered to the shucking house, while others are injured in culling and perish. Shells of young are easily broken by the teeth of heavy dredges adjusted to take large oysters and harvesting sometimes results in the destruction of large numbers of undersized specimens.

On the other hand, a unit of the planted bottom of a well-conducted farm contains a population of oysters of a uniform age which are placed in a desired concentration and are not disturbed by dredging. There is less competition for food and the oysters have better conditions for rapid growth and fattening. Harvesting from a cultivated bottom does not require culling and is, therefore, more efficient and economical.

In planting operations as usually conducted by State governments, no attention is paid to the segregation of oysters of various ages. Thus, in spite of the efforts and money expended, the planted bed still retains all the undesirable conditions of a wild "natural" one, under which production in pounds of meat per acre cannot be high.

MANAGEMENT OF PUBLIC GROUNDS

Considerable improvement in the management of public oyster grounds can be expected if state planting operations are conducted by a plan similar to that used by private oyster growers. Simple computation shows that it is more advantageous to plant spat than seed oysters two or three years old. A bushel of shells containing about 2,000 spat may be expected to produce, by the end of the third year, between 4 and 5 bushels of marketable oysters (assuming 300 oysters to a bushel and cumulative mortality

of 20 percent). With the higher concentration of spat that sometimes prevails, an even higher yield of 6 to 7 bushels from 1 bushel of spat may be attained. However, a return of 1:1 is the average that can be expected from planting 2- and 3-year-old seed. Since the cost of planting one bushel of shells with spat or one bushel of seed oysters is about the same, the advantages of planting the former are obvious.

To ensure a sufficient supply of seed, existing setting areas should be utilized to establish spawning grounds closed to fishing, and by providing cultch. State grounds from which planters are permitted to take seed for planting should be protected by prohibiting the removal of adult oysters and shells. The taking of these is probably one of the chief reasons for the exhaustion of seed grounds in Delaware Bay. The situation can be easily remedied by the enforcement of existing laws and by the establishment of sanctuaries.

Planted areas should be closed to fishing and opened only when the oysters reach marketable size. Then the bed can be opened to fishing and the oystermen encouraged to remove and market all of the oysters in order to have the ground ready for the next planting. Since natural growth of an oyster population is not great enough to keep pace with the rate of commercial fishing, no good purpose is served by leaving marketable oysters on planted ground. They should be removed and replaced by seed.

Harvesting of oysters should be regulated because the opening of state-cultivated grounds to free fishing may result in such a rush and competition among the dredgers and tongers that the market may be glutted, prices fall, and the harvest largely wasted. These undesirable features, which in the past have caused great confusion and disorganization in the fishing industry, can be avoided by establishing a daily catch limit per boat, and by restricting the number of boats, or both. This can be accomplished by various means, as by issuing special permits good for a limited period and by checking the boats and their loads when they leave the grounds. For the successful operation of a program of state management, the control of the harvesting is as important as the production of the crop.

In carrying out this general scheme it is suggested that, at first, the badly depleted bottoms be set aside for state planting. Since fishing on them is unprofitable, their closing will not interfere with the existing fishery. The areas selected for planting should be closed, posted, and cleaned.

From the very beginning, distinction should be made between the setting and growing grounds and no shells should be planted on the latter except for reinforcing soft bottoms. Depending upon local conditions and the time required for the oysters to reach marketable size, grounds should be used in rotation to be ready for harvesting in 2, 3, or 4 years.

Two questions naturally arise: (1) How should these oyster-farming operations by the state be financed, and (2) why should all the work be carried out for the benefit of the oystermen who appear only as reapers of a crop

they do not plant? An indirect subsidy to the oystermen from the general taxpayer's money can be avoided if, for the privilege of harvesting from planted areas, a special assessment is made on each bushel or gallon of oysters taken, and the money so collected is in turn spent on the improvement program. Funds for shell planting which several states have at their disposal could be used to defray initial expenses. At present, this money is spent in more or less indiscriminate planting and is usually dissipated without producing permanent improvement. Suppose that under a new system of management, the state plants several thousand acres of prepared, good grounds at the rather high cost of 75 cents a bushel of shells, each containing about 2,000 spat. By the end of the third year when the oysters are ready for market, they can be expected to yield about 4 1/2 bushels to one of the original seed. The grounds would then be open to the oystermen who would pay, however, a special assessment for the privilege of taking cultivated oysters, and whose catch should be regulated.

Harvesting oysters from cultivated grounds requires less effort than working on depleted natural beds where oysters are scarce, and it is reasonable to expect that the oysterman would be able to make a good profit even if assessed at the rate of 20 cents a bushel. Because the yield of cultivated oysters in pints per bushel averages higher than that of wild ones, the assessment covering the cost of cultivation cannot be considered too burdensome, especially if the market price of oysters remains at the present level. Even at a selling price of $1.00 a bushel the oystermen would be able to make a substantial profit because of the better yield and consequent higher efficiency of harvesting on planted areas. At the rate of 20 cents a bushel, the State would collect 90 cents (4 1/2 x 20) for each 75 cents invested in the planting and could apply the money to a revolving fund from which further oyster farming operations would be administered and finance The figures suggested are here given only in illustration and should not be considered as definite recommendations. The proper rate of assessment would vary in different states and in different years depending on the success of planting operations, market conditions, and other factors. The assessment is restricted to the crop harvested from state-planted grounds and does not apply to other beds under the jurisdiction of the state that are not cultivated. For collecting the assessment, a system of checking can be adopted similar to that now in operation in Louisiana. Oysters gathered in Louisiana for the canneries at Biloxi, Mississippi, must be cleared through a port of entry where a certificate is given showing the number of bushels and the point of origin of oysters taken outside of state waters. Payment of the assessment is made through the operator of the plant receiving the oysters. I believe a similar system for the collection of a special assessment on cultivated oysters taken from state-planted grounds can be worked out in every state.

The proposed system of management can be put into operation gradually, by a state, beginning with a limited area, carefully selected, in a section where it can easily be patrolled.

In states where strong antagonism exists between the tongers and the dredgers, a certain degree of reconciliation may be attained by offering to both groups an opportunity to participate with the state in oyster-farming operations. Dredgers who agree to prepare the bottoms and plant specified

amounts of shells or seed may receive in return preferred rights in harvesting the crop. Similarly, tongers may be encouraged to engage in the production of seed by planting shells and other cultch in the inshore waters and selling their surplus to the state. It is believed that in this way production of seed oysters can be increased. Tongers who own small farms along the shores can obtain additional income from this source and utilize with profit the time they are not engaged in fishing. Other methods of cooperation between the state and the oystermen can be devised. For instance, the right to harvest planted oysters may be offered at public auction and granted to the highest bidders.

It is not the present purpose to discuss details of organization which obviously must differ in the various states, in accordance with natural, economic, and social conditions. It should be reemphasized, however, that the productivity of oyster bottoms can be maintained only through cultivation. If the development of private oyster-farming is impossible, then the cultivation of bottoms must be carried out by the state governments. In the majority of the states, the management of the oyster fisheries is in the hands of the legislative bodies and often becomes a political issue in which the interests of conservation are submerged or lost. Even in states where the administrative officer enjoys discretionary power, his tenure of office is indirectly dependent on the voters. Many difficulties in the past can be attributed to the failure of state administrators to acquaint the fishermen with the reasons for adopting certain restrictive measures. The success of a new system of management of oyster bottoms, as outlined above, depends on the support it may receive from the people who earn their livelihood by oystering. It is, therefore, essential to popularize new ideas among the oystermen through meetings, publications, and demonstrations and to gain their confidence by organizing local councils to formulate their specific needs and discuss ways of overcoming difficulties. The animosity between the fishermen who naturally want to use the most effective methods of fishing and the administrator who restricts their activity can be minimized or eliminated if attempts are made to explain the principles of management and make the fishermen a party to the conservation effort. The task may be difficult especially at the beginning but it is certain to produce good results in the long run.

The execution of a new program of management must be based on a thorough knowledge of local grounds and on an understanding of the behavior of oysters in each locality. It will be necessary, therefore, to have a staff of competent oyster biologists or oyster culturists to study local conditions and to direct oyster farming operations. Extensive experimental research may be needed in many localities in order to determine the best method of rehabilitation of oyster bottoms and their protection against enemies, parasites, and pollution. These are services which, perhaps, may best be rendered by a Federal or interstate organization.

SEED OYSTERS

Students of oyster problems in the United States realize that the production of spat and of an adequate supply of seed is essential to success of the industry. Future progress is dependent on our ability to produce

seed oysters in the localities, and at the times when they are needed. In past years, considerable progress has been made in acquiring knowledge of the factors that control the spawning and setting of oysters, but still more specific information is needed in order to understand how the oyster larvae react to the outside environment and why they set successfully in one place and fail to do so in another. It is well-known that good setting grounds may be very poor for the growing of oysters and that good maturing grounds may be useless for catching spat. In general, the best seed grounds are close to the mouths of rivers in waters of low salinity.

Seed grounds close to industrial and densely populated areas suffer more from industrial and domestic pollution than do those located farther offshore in deeper waters. A great many formerly productive seed-oyster grounds have been destroyed by industrial wastes. Furthermore, seed areas cannot be fully utilized because they are under the jurisdiction of municipal or county governments which have a tendency to issue regulations intended to protect the rights of local residents rather than those of the entire state or country. Under these conditions full utilization of the seed-oyster possibilities becomes impossible.

Observation of the practices employed by private growers and by some of the state governments shows that transplantation of seed is often carried on without proper safeguards. For instance, no effort, as a rule, is made to remove the oyster-drills and their egg-capsules and no attention is paid to the condition of young oysters. Recent studies disclose that on many of the natural seed grounds, especially in southern waters, the oysters are badly infected with a protozoan parasite (Nematopsis). Yet rather large quantities of the infected seed have been gathered and planted among healthy oysters. Apparently, Nematopsis infection does not destroy the oysters under normal conditions and it is firmly established that the parasite is not injurious to human health, yet there is no doubt that its presence is undesirable for it may affect the quality of the oysters and even render them unmarketable. As in the case of the oyster-drills, which are being spread primarily by the oystermen, the Nematopsis parasites also are distributed over a wide range through carelessness of the planters.

The problem of adequate production of healthy seed oysters is a serious one that should be given careful attention by the state governments. Establishment of spawning and seed reserves appears to be one of the methods of meeting the situation, and of making good use of many of the depleted and abandoned public grounds.

CONTROL OF ENEMIES

Depredation by starfishes continues to be a major concern of oyster-growers in the North. That starfish infestation can be controlled and that thousands of pounds of oyster meat devoured by these pests can be saved for human consumption have been demonstrated by the work of biologists of the Fish and Wildlife Service and others. It has been shown also that, to be a success, the control of starfishes requires organized effort on the part of private oyster-growers and the state governments.

Surveys conducted by the U. S. Fish and Wildlife Service in Long Island Sound give ample evidence that abandoned private beds neglected by the owners, and unattended natural beds neglected by the state, are the principal breeding places of starfishes. It is an obvious responsibility of the state government to prevent publicly owned grounds from becoming a menace to the nearby private oyster-farms. On the other hand private planters, in fairness to their neighbors, should be required to free their uncultivated plots from dangerous pests.

POLLUTION

The increase in domestic pollution of inshore waters is a serious obstacle to the progress of the shellfish industry. Evidence indicates that not only is there a considerable increase in the spread of domestic pollution, resulting from increased war production activities, and the construction of new military and naval establishments and housing projects for war workers, but that there is a tendency on the part of the health officers to relax their vigilance. The interests of the oyster industry demand that public health be fully safeguarded and that no compromise be accepted where there is danger of an infected product reaching the market. For the sake of self-preservation the industry should insist on strict enforcement of public health regulations. In doing so, it will prevent repetition of the disaster of 1925.

Industrial pollution also interferes with the oyster industry. Various chemicals, oils, and pulp-mill wastes enter our coastal waters in ever-increasing quantities. Extensive research is necessary in order to devise methods of purification, or recovery of various wastes so that they will not be discharged into our bays and estuaries and accumulate on the shellfish bottoms. The toxic effect of many of the pollutants has been demonstrated by numerous studies conducted by the U. S. Fish and Wildlife Service and by various state and university laboratories in this country and abroad. Many progressive manufacturers show their willingness to cooperate with those engaged in the conservation of our food resources, while others protest the results of scientific findings and try to prove that the wastes that are discharged into the waters are not only harmless to marine life but are even stimulating to its propagation and growth.

The solving of pollution problems should be sought through cooperation in research conducted jointly by fishery biologists and the technologists working for manufacturing concerns. Scientific and technical studies of the method of recovery and purification of industrial wastes may lead to economies and funds expended for this purpose, in the long run, will bring higher dividends than money spent in unconstructive litigation.

CONCLUSION

It has been shown that the potential productivity of shellfish bottoms is much greater than their present yield and that the decline in the production of oysters is due to lack of cultivation on public grounds. The rehabilitation of depleted bottoms can be attained by adopting a system of management which will result in their development and permit long-continued utilization. Certain principles of such a system have been suggested to stimulate interest and focus attention on the urgent need for

modifying obsolete and inefficient methods of administration of the oyster fishery. The management of shellfishery resources is a state problem that should be solved separately by the citizens of the various states through their legislative bodies. Action should be prompt as our present system, or lack of one, is leading to the gradual depletion of our valuable shellfish resources. However, it is certain that production can be materially increased by following certain basic principles of cultivation and management.

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